Section 6

TROUBLESHOOTING

This section contains technical information on:

- ❑ Product Experience Report (PER) Registration
- ❑ Product Returns
- ❑ Abbott Technical Assistance
- ❑ Troubleshooting Process
- ❑ Service Alarms
- ❑ Operation Alarms

6.1 CONTACTING THE MANUFACTURER

Table 6-1. Contact Information

For assistance with:	Do the following:
❑ Pump operation and programming ❑ Technical inquires ❑ Spare parts and manuals ❑ Training information	*In the USA:* Operational and technical assistance is available Monday through Friday between 6:00 AM and 4:00 PM PST at Abbott Laboratories Technical Support Operations (TSO): **1-800-241-4002** **or** **www.abbotthpd.com** *Outside the USA:* Contact the nearest Abbott Laboratories representative for assistance.
❑ Product Returns	Contact Abbott Laboratories HPD - Morgan Hill at **1-800-241-4002** to register the Product Experience Report before shipping the device. Send prepaid product returns to: **Abbott Laboratories** **Technical Support Operations** **755 Jarvis Drive** **Morgan Hill, CA 95037** ✎ **Note:** When possible, please return all sets involved in any product experience to facilitate the investigation process. Do not return product without prior approval from Abbott Laboratories HPD - Morgan Hill.

6.2 TROUBLESHOOTING REFERENCES

The following information is provided to assist in troubleshooting the Abbott GemStar pump. Most problems can be easily resolved through non-invasive recovery procedures.

Troubleshooting should always start with a basic pump inspection to isolate and eliminate common pump/cassette interface problems and user errors. Refer to *Figure 6-1, Troubleshooting Process Flowchart* for an overview of the troubleshooting process.

6.2.1 TROUBLESHOOTING TOOLS

The following tools are available to help isolate and resolve many pump problems *(see Table 6-2, Troubleshooting Tools).*

Table 6-2. Troubleshooting Tools

Section	Description	Purpose
6.2.3	Alert/Alarm Message Index	Provides the appropriate reference for a specific error type
6.2.4	Printing Device History	Provides significant events, in chronological order, such as programming and pump performance history
5.1.2	Pump Inspection	Provides information for inspecting the physical and functional parameters of the pump to assure optimal performance
5.2	Operation Test	Verifies pump operation, including programmability, pressure and air sensitivity, and volume accuracy

Note: Abbott Certified Technical Service Training is required for troubleshooting that involves pump disassembly and recertification. Contact Technical Service Operations for training availability. Refer to *Section 6.1, Contacting the Manufacturer,* for contact information.

6.2.2 TROUBLESHOOTING PROCESS FLOWCHART

The following process flow *(see Figure 6-1)* should be used along with *Table 6-2* when troubleshooting the Abbott GemStar pump.

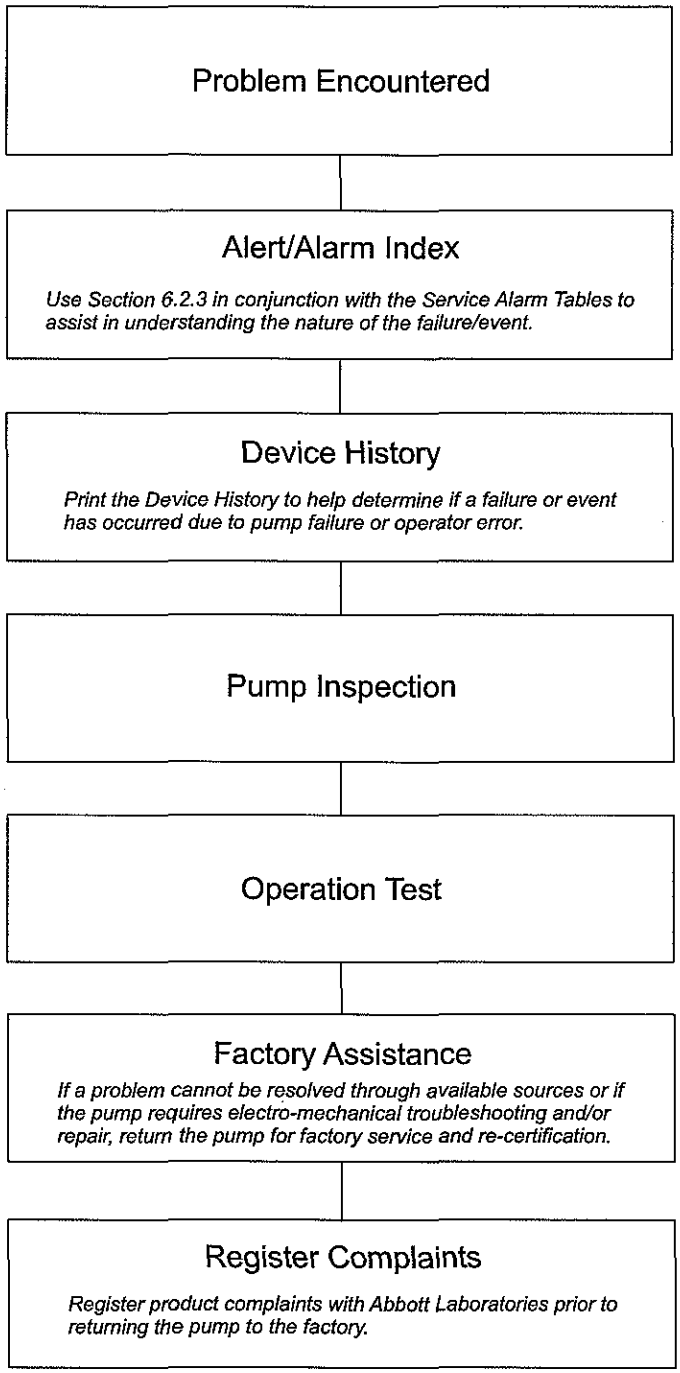


Figure 6-1. Troubleshooting Process Flowchart

6.2.3
ALERT/ALARM MESSAGE INDEX

Table 6-3. Alert/Alarm Message Index

Error Type	Display/Description	Reference
Alert Message	ALMOST EMPTY CHECK PRINTER EMPTY CONTAINER FLASHING DISPLAY PROGRAM INCOMPLETE START	*Abbott GemStar System Operating Manual*
Sensor Alarm	AIR-IN-LINE DISTAL OCCLUSION PROXIMAL OCCLUSION	
Alarm Message	CHANGE BATTERIES CHECK CASSETTE LOW BATTERIES POWER LOSS USING BATTERIES	
Service Alarm	CALL 1.800.XXX.XXXX CODE: NN/MMM/TTT	*Section 6.3, Service Alarm Codes* *Section 6.1, Contacting the Manufacturer*
Other Display Messages	KEYPAD LOCKED	*Abbott GemStar System Operating Manual*
	NOT ALLOWED DURING INFUSION PROCESS PRESS STOP TO HALT DELIVERY	
	ROUNDING	
	DOSE IN PROGRESS NEW CONTAINER NOT ALLOWED	
	CANNOT CHANGE CLOCK WHILE THE BASE DELIVERY IS IN PROGRESS	
	PROGRAM EXCEEDS MAX CONTAINER SIZE. CHANGE PROGRAM VALUES	

Table 6-3. Alert/Alarm Message Index		
Error Type	**Display/Description**	**Reference**
Other Display Messages	THIS OPTION IS NOT AVAILABLE WHILE PROGRAMMING THE PUMP	*Abbott GemStar System Operating Manual*
No Display	No power or sign of functionality	*Figure 6-1, Troubleshooting Process Flowchart* *Section 6.1, Contacting the Manufacturer*
Locked-Up	Pump is powered on but is not responding	*Section 5.2.5 , Restoring The Pump For Use*

6.2.4
PRINTING DEVICE HISTORY

Note: Refer to the *Abbott GemStar System Operating Manual* (Options Menu) for additional printing instructions and configuration settings for the Seiko® DPU 414 printer.

1. Turn on the pump.
2. Wait for the Unit Self Test to complete, then press [YES/ENTER].
3. Connect the printer to the pump.
4. Press [OPTIONS].
5. Select HISTORIES from the Options Menu.
6. Select HISTORY from the Histories menu to begin printing.

6.3
SERVICE ALARM CODES

The following sections provide the following:

- ❑ Explanation of service alarm codes
- ❑ Service alarm code quick reference
- ❑ Service alarm code details

6.3.1
EXPLANATION OF SERVICE ALARM CODES

Service alarm codes are displayed in the following format *(see Table 6-4, Error Description)*:

Table 6-4. Error Description		
Primary	Supplemental	Type
NN	MMM	TTT

Service alarms indicate maintenance or repair of the pump is required to restore proper pump performance.

- For a quick reference of the service alarms refer to *Section 6.3.2, Service Alarm Code – Quick Reference.*
- For service alarm details, including the error description and possible causes, refer to *Section 6.3.3, Service Alarm Code – Detail.*

6.3.2
SERVICE ALARM CODE – QUICK REFERENCE

Table 6-5. Service Alarm Code – Quick Reference	
Error	Description
01/000	CONFIG register contents are not what is expected
02/000	Stack error
03/000	Invalid interrupt
03/001	Interrupt overlap
03/002	Invalid IRQ interrupt
04/000	RAM Test error
05/000	EEPROM write error – data read back does not match data written
05/001	EEPROM write error – invalid EEPROM address
06/000	Pump configuration CRC error
06/001	Infusion data CRC error
06/002	Pump data CRC error
06/003	Program data CRC error
06/004	Speed protocol CRC error
06/005	ROM CRC error
06/006	Protected variable error
06/007	Dose data CRC error

Table 6-5. Service Alarm Code – Quick Reference	
Error	**Description**
06/008	Air calibration CRC error
06/009	Pressure calibration CRC error
06/010	Motor calibration CRC error
06/011	Settings CRC error
07/000	High air sensor value
07/001	Negative volume sampled
07/002	Bad air sensor state
07/003	Bad air sensor event
07/004	Air sensor not calibrated
07/005	Excessive volume sampled
08/005	Bad pressure sensor event
08/006	Bad pressure sensor state
08/007	Distal pressure is out of range
08/008	Proximal pressure is out of range
09/000	Short term overdelivery
09/001	Backward motor movement
09/002	Motor not calibrated
09/006	Power on motor test
09/007	Motor not turning when it should be
09/008	Bad motor state
09/009	Bad motor event
09/010	Bad motor rate
09/011	Motor stack error
09/012	Motor step overlap
09/013	Motor control error
09/014	Bad motor step number
09/015	Motor overshot IPRF step
09/016	Motor encoder overflow
09/017	Bad restart command
09/018	Motor overdelivery
09/019	Motor underdelivery
09/020	Motor runaway

Table 6-5. Service Alarm Code – Quick Reference	
Error	**Description**
10/000	Beeper error
11/000	More than 5.5 volts measured on the 5 V line
11/001	Less than 4.5 volts measured on the 5 V line
11/002	More than 3.2 volts measured on the AA battery voltage input
11/003	More than 3.6 volts measured on the external voltage input
11/004	Less than 2.0 volts measured on the lithium battery input
12/000	Stuck key
13/000	IRQ test of oscillator – timing error
13/001	RTI test of one second interrupt – timing error
14/001	Watchdog timeout – motor turning when it should not be
14/003	Watchdog error – task not responding
15/000	Power down error
16/001	Air-in-line active when it should not be
16/002	Key event timeout
16/003	Invalid alarm semaphore
16/004	Invalid alarm message
16/005	Invalid alarm type
16/006	Invalid alarm callback
16/007	Invalid sound type
16/008	IQUEUE full
16/009	Infusion safety task received an invalid message type
16/010	Infusion safety task received a null message type
16/011	Infusion safety task received an invalid pressure message
16/012	Infusion safety task did not receive the expected queue information
16/013	Infusion safety task received an invalid semaphore value
16/014	Infusion safety task received an invalid air message
16/015	Infusion safety task received an invalid check cassette message
16/016	Infusion safety task received a resume without an initial start
16/017	Infusion safety task detects a rate mismatch
16/018	Infusion safety task detects a mode mismatch
16/019	IED has message conflict
16/020	Remote queue out full

Table 6-5. Service Alarm Code – Quick Reference	
Error	**Description**
16/021	Remote queue out empty
16/022	Remote queue out bad state
16/023	ISA bad rate
18/000	History pointer error while inserting a new record into the history log
18/001	History pointer error while traversing to bottom of history
18/002	History pointer error while traversing to top of history
21/000	Remote communication input buffer error
21/001	Keypad queue error
21/002	Remote communication input message error

6.3.3
SERVICE ALARM CODE – DETAIL

Table 6-6. Service Alarm Code – Detail				
Primary Error (NN)	**Supplemental Error (MMM)**	**Type (TTT)**	**Error Detection Method**	**Error Description/ Possible Causes**
01 (CPU_ ERROR)	000 (CONFIG_REG)	CONFIG register contents	At power on, the contents of the CONFIG register is tested for the expected value. If the contents are invalid, a service alarm occurs.	The CONFIG register does not contain the expected value due to: • CPU failure • EEPROM failure
02 (STACK_ ERROR)	000	Stack # 0 = RTXC Stack 1 = SCI_INPUT Stack 2 = SCI_OUTPUT Stack 3 = IED Stack 4 = UI Stack 5 = DISPMGR Stack 6 = INFUSION Stack 7 = ISAFETY Stack 8 = ALARM Stack 9 = NISAFETY Stack 10 = HISTORY Stack 11 = REMOTE OUT Stack 12 = STACKMAX	Each stack is initialized during power on. Once per second, these values are checked for corruption. If a guard byte has been overwritten, a service alarm occurs.	Stack overflowed due to • CPU failure • Flash RAM failure • RAM chip failure • Bus failure

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
03 (INTERRUPT _ERROR)	000 (INVALID_ INTERRUPT)	Interrupt # 1 = SPI_INTERRUPT 2 = PAIE_INTERRUPT 11 = TIC2_INTERRUPT 12 = TIC1_INTERRUPT 18 = NOCOP_ INTERRUPT 19 = CME_INTERRUPT	All unsupported ISRs, when called, are trapped in a service alarm.	An unsupported interrupt has been called due to: • Flash RAM failure • Bus Failure • CPU failure • RAM chip failure
03 (INTERRUPT _ERROR) cont.	001 (INTERRUPT_ OVERLAP)	Interrupt # 0 = SCI_INTERRUPT (serial port) 3 = PAO_INTERRUPT (motor forward counts = 256) 4 = TO_INTERRUPT (timer overflow–general purpose timing) 5 = TOC5_INTERRUPT (air monitoring) 6 = TOC4_INTERRUPT (keypad scanning) 7 = TOC3_INTERRUPT (pressure monitoring) 8 = TOC2_INTERRUPT (motor control) 9 = TOC1_INTERRUPT (output shaft sensor scanning) 10 = TIC3_INTERRUPT (motor backward ticks) 13 = RTI_INTERRUPT (system clock, watchdog servicing, stack checking) 14 = IRQ_INTERRUPT (real-time clock chip interrupt) 15 = XIRQ_INTERRUPT (power loss)	Each interrupt service routine has a unique activity flag associated with it. The flag is set upon entry into the ISR and cleared upon exit. If on entry, the flag is already set, a service alarm occurs.	An interrupt was called again before the last execution completed due to: • Flash RAM failure • Bus Failure • CPU overload
	002 (INVALID_IRQ_ INTERRUPT)	IRQ Status Byte	Upon entry into the ISR, a processing flag is set to FAILURE. As the individual bits are processed, the flag is set to SUCCESS. If no flags are processed, a service alarm occurs.	The IRQ interrupt was called but no interrupts were processed due to: • CPU failure • FPGA failure • Timer chip failure • Output shaft sensor failure

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
04 (RAM_ ERROR)	000 (INTERNAL_ TEST)	Test # 0 = Power on Test 1 = Background Test	At power on and continuously during operation, all RAM locations are tested by writing patterns of 0XAA and 0X55 and by address count up.	Read/write test to internal RAM failed due to: • CPU failure
05 (EEPROM_ WR_ERROR)	000	N/A	All writes to CPU EEPROM are processed via a common function which reads back the EEPROM contents following a write. If the data read back following the write does not match the data written, a service alarm occurs.	Unable to write to EEPROM in the 68HC11 chip due to: • CPU EEPROM failure • CPU failure
	001	N/A	All writes to CPU EEPROM are processed via a common function. If the function receives an invalid EEPROM address, a service alarm occurs.	Unable to write to EEPROM in the 68HC11 chip due to: • RAM chip failure • Bus failure
06 (CRC_ CHKSUM_ ERROR)	000 (PUMP_ CONFIG_CRC)	N/A	The configuration data integrity is verified • Before viewing • Before printing • Before using in rate-lock change function • Before using in menu function • At power on • Whenever any dose is started or restarted If the CRC stored with the configuration data does not match the calculated value, a service alarm occurs.	The computed configuration CRC value does not match the stored value due to: • CPU EEPROM failure • CRC calculation error

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
06 (CRC_ CHKSUM_ ERROR) cont.	001 (INFUSION_ DATA_CRC)	N/A	The infusion data integrity is verified at power on and once per second while the infusion task is running. If an invalid infusion data pointer is found or if the CRC stored with the infusion data does not match the calculated value, a service alarm occurs.	The computed infusion data CRC does not match the stored value due to: • RAM chip failure • Bus failure • CRC calculation error
	002 PUMP_DATA_ CRC)	N/A	The pump data integrity is verified at power on and once per second while the infusion task is running. If the CRC stored with the pump data does not match the calculated value, a service alarm occurs.	The computed pump data CRC does not match the stored value due to: • RAM chip failure • Bus failure • CRC calculation error
	003 (PROGRAM_ CRC)	N/A	The pump program data integrity is verified: • Entering stop mode • Entering run mode • When a new program is sent to Infusion • Whenever any dose starts or restarts If the CRC stored with the pump program data does not match the calculated value, a service alarm occurs.	The computed pump program CRC does not match the stored value due to: • RAM chip failure • Bus failure • CRC calculation error

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
06 (CRC_ CHKSUM_ ERROR) cont.	004 (SPEED_ PROTOCOL_ CRC)	Speed Protocol #	The speed protocol data integrity is verified: • Before printing a SP • Before viewing a SP • Before assigning a SP • Before deleting a SP • Before retrieving a SP If the CRC stored with the speed protocol data does not match the calculated value, a service alarm occurs.	The computed speed protocol CRC does not match the stored value due to: • RAM chip failure • CRC calculation error
	005 (ROM_CRC)	N/A	The Flash RAM data integrity is verified at power on and once every hour. If the checksum stored in the Flash RAM does not match the calculated value, a service alarm occurs.	The computed FLASH RAM checksum does not match the stored value
	006 (PROTECTED_ VAR)	Variable Type 003 = Air State 004 = Pressure State 006 = Distal Pressure Threshold 007 = Proximal Pressure Threshold	Critical data used in air and pressure sensing is mirrored in RAM when written. When read back, the data and its mirrored value is compared to verify data integrity. If the data value cannot be verified, a service alarm occurs.	The protected variable value is corrupted due to: • RAM chip failure • Bus failure • CPU failure

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
06 (CRC_ CHKSUM_ ERROR) cont.	007 (DOSE_DATA_ CRC)	Dose Type	The dose data integrity is verified at power on, once every second and at the start of a new dose. If the CRC stored with the dose data does not match the calculated value, a service alarm occurs.	The computed dose data CRC does not match the stored value due to: • RAM chip failure • CRC calculation error
	008 (AIR_CAL_ CRC)	N/A	The air calibration data integrity is verified at power on and in the background. If the CRC stored with the air calibration data does not match the calculated value, a service alarm occurs.	The computed air calibration data CRC does not match the stored value due to: • CPU EEPROM failure • CRC calculation error
	009 (PRESS_CAL_ CRC)	N/A	The pressure calibration data integrity is verified at power on and in the background. If the CRC stored with the pressure calibration data does not match the calculated value, a service alarm occurs.	The computed pressure calibration data CRC does not match the stored value due to: • CPU EEPROM failure • CRC calculation error
	010 (MOTOR_CAL_ CRC)	N/A	The motor calibration data integrity is verified at power on and every time a start delivery command is sent to infusion safety. If the CRC stored with the motor calibration data does not match the calculated value, a service alarm occurs.	The computed motor calibration data CRC does not match the stored value due to: • CPU EEPROM failure • CRC calculation error

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
06 (CRC_ CHKSUM_ ERROR) cont.	011 (SETTINGS_ CRC)	0 = Error when entering a function that will alter the pump settings 1 = Error when entering a function that displays the current lock levels	Verifies the settings data is correct when: • Displaying the lock levels • Entering Run Mode or Stop Mode • Changing the PM Rate, PM Bolus Dose, or Occlusion Setting	One of the following is corrupted: • Lock Level • Occlusion Setting • Default Occlusion Setting • PM Rate Lock Ranges
07 (AIR SENSOR ERROR)	000 (HIGH_VALUE)	Measured Value	When evaluating the air sensor state, the measured pre-trigger value is compared with the level set during calibration. If the measured value is greater than the calibration value, a service alarm occurs.	Air sensor returning too high a value due to: • Calibration error • Air sensor receiver fault
	001 (AIR_NEGATIVE _VOLUME)	N/A	The volume delivered between check-points is calculated each checkpoint. If the volume is negative and more than one stroke has been delivered, a service alarm occurs.	Negative volume sampled due to: • RAM chip failure • 180 degree miscalibration of the output shaft encoder
	002 (AIR_BAD_ STATE)	State #	The state variable was not one of the recognized states for the pressure software.	The air sensor was in an invalid state due to: • RAM chip failure
	003 (AIR_BAD_ EVENT)	Event #	If an event code is received that is not one of the recognized events for the air software, a service alarm occurs.	The air sensor received an invalid event due to: • RAM chip failure
	004 (AIR_NOT_ CALIBRATED)	0	The AIR MAX PRE LEVEL is checked to see that it is not zero at power up. If it is zero, a service alarm occurs.	The air sensor calibration values are not within the expected ranges due to: • Calibration error • EEPROM failure

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
07 (AIR SENSOR ERROR) cont.	005 (AIR_ EXCESSIVE_ VOLUME)	N/A	The volume delivered between check-points is calculated each checkpoint. If the volume exceeds 100 µL, a service alarm occurs.	Excessive volume sampled due to: • RAM chip failure • 180 degree miscalibration of the output shaft encoder • CPU overload
08 (PRESSURE_ SENSOR_ ERROR)	005 (PRESS_BAD_ EVENT)	Bad Event #	Pressure sensor software checks events it receives against a list of valid events. If a received event is not in the list, a service alarm occurs.	The pressure sensor received an invalid event due to: • RAM chip failure • Bus failure
	006 (PRESS_BAD_ STATE)	State #	If processing is not defined for a state value, a service alarm occurs.	The pressure sensor state variable was invalid due to: • RAM chip failure • Bus failure
	007 (PRESS_ DISTAL_ RANGE)	N/A	When delivery is started and after the plunger passes home, the distal threshold is recomputed. If it is not in the range 0–255, a service alarm occurs.	The distal pressure is out of range due to: • Corruption of calibration data used to compute pressure • Computation error in H/W or S/W • RAM error
	008 (PRESS_ PROX_RANGE)	N/A	When delivery is started, the proximal occlusion threshold is recomputed. If it is not in the range 0–255, a service alarm occurs.	The proximal pressure is out of range due to: • Corruption of calibration data used to compute pressure • Computation error in H/W or S/W • RAM error

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
09 (MOTOR_ ERROR)	000 (MOTOR_IPRF_ ENC _OS_SYNC)	Step where problem occurred	IPRF steps, in general, are expected to begin on the "pump" side of the stroke. If the microprocessor misses motor encoder counts, the plunger will advance further than it should, resulting in a short-term overdelivery. Before beginning to deliver the next step, the software tests the output shaft flag position to detect that it is still on the "pump" side of the stroke. There are several exceptions to this: Step 0 of any delivery; Step 7 of an 8-step delivery; Steps 13, 14, and 15 of a 16-step delivery. (continued)	Microprocessor misses motor encoder counts Note: This error will never be reported for single step IPRF (30.1 mL/hr to 125 mL/hr).

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
09 (MOTOR_ ERROR) cont.	000 (MOTOR_IPRF_ ENC _OS_SYNC) cont.	Step where problem occurred	The last step of a stroke frequently overshoots its stopping position, near full extension, so step 0 often starts on the "fill" side. If the output shaft has the maximum positive offset (+10), all other steps can be expected to start on the output shaft flag. If the output shaft has the maximum negative offset (-30), any step beginning at a position under 186 should be expected to start on the output shaft flag. The steps that may not start on the flag is this case are step 7 of an 8-step delivery and steps 13 through 15 of a 16-step delivery.	Microprocessor misses motor encoder counts Note: This error will never be reported for single step IPRF (30.1 mL/hr to 125 mL/hr).

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
09 (MOTOR_ ERROR) cont.	001 (MOTOR_ BACKWARD_ MOVEMENT)	(Type 1—single rollback greater than 40 counts) • Number of backward encoder counts (Type 2—excessive accumulation of rollbacks greater than 16 counts) • Accumulated backward counts in excess of 16 Error log data, type 1 only: 26/000/sss 26/fff/bbb 26/ppp/aaa Where: sss = iprf step number fff = forward count register (*PACNT) bbb = total back ticks this stroke ppp = distal pressure (ADC) aaa = distal alarm flag (1 = alarm) Also, for each rollback greater than 16 counts, Error log contains: 29/ppp/rrr 29/ccc/nnn Where: ppp = distal pressure (ADC) rrr = rollback amount, ticks ccc = count of large rollbacks within this 16-stroke window nnn = net position (fwd – back counts) at start of this step.	(Type 1) The motor encoder backward count accumulator tests the number of counts each time a count is accumulated. If the backward count exceeds the limit (40), a service alarm occurs. (Type 2) Also, each time the motor is started, if the number of backward counts in the previous rollback is greater than 16, the amount in excess of 16 is accumulated. This accumulation is cleared every 16 strokes. If the accumulation exceeds 40 counts, a service alarm occurs.	Excessive motor backward movement due to: • High distal pressure • Motor clutch failure • Motor gearbox failure

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
09 (MOTOR_ ERROR)	002 (MOTOR_NOT_ CALIBRATED)	Error Type 0 = Invalid PWM 1 = Stroke volume 2 = Motor slope 4 = Output shaft offset	The motor calibration values are tested at power on to verify they are within expected ranges. If a value is out of range, a service alarm occurs. For each new rate, a PWM is calculated. If the calculated value is less than the minimum set during calibration, a service alarm occurs.	The motor calibration values are not within the expected ranges due to: • Calibration error • EEPROM failure
	006 (NO_MOTOR_ CONTROL)	Error Type 1 = Shorted switch FET 2 = Backward movement 3 = Motor does not turn 4 = Motor runs too fast 5 = Motor runs backward Error log data for 09/006/003: 24/000/iii 24/fff/ppp Where: iii = motor current (ADC) fff = forward count register (*PACNT) ppp = distal pressure (ADC)	At power on, a motor test is performed to verify that, with other motor controls set, the motor does not turn when the motor switch FET is off and that the motor does turn when the motor switch FET is on. If a test fails, a service alarm occurs.	The power on motor control test failed. • Independent motor switch FET failed • Motor wiring error • Motor encoder strobe failure • Motor encoder failure • PIC became active (003) • PIC Failure (003)

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
09 (MOTOR_ ERROR) cont.	007 (MOTOR_ NOT_ PUMPING)	State #, Event # The type field is displayed as xy where x is the state # and y is the event #. No movement while: 016 = Homing 036 = Stepping 046 = Continuous 066 = Ramping Up ERROR LOG DATA: 25/fff/bbb 25/vvv/iii 25/sss/000 25/ppp/aaa 25/nnn/ttt 25/ooo/eee 25/ddd/ccc 25/aal/prx Where: fff = forward count register (*PACNT) bbb = mticks_back_stroke iii = motor current (ADC) vvv = motor voltage (ADC) sss = motor speed (pwm) ppp = distal pressure (ADC) aaa = distal alarm local flag (1= alarm) nnn = motor encoder enable (1 = on) ttt = motor encoder strobe (1 = on) ooo = motor drive on (1 = on) eee = motor drive enable (1 = on) ddd = distal occlusion alarm condition (1 = on) ccc = check cassette alarm condition (1 = on) aal = air alarm condition (1 = on) prx = proximal occlusion alarm condition (1 = on)	Motor movement is tested during ramp up, IPRF homing, IPRF stepping, and continuous delivery. If the PWM value to the motor reaches 200 and no movement is detected, a service alarm occurs.	No encoder counts detected when the motor is supposed to be running due to: • Motor drive failure • Motor encoder strobe failure • Motor encoder failure • PIC became active The motor was off when it should not be due to: • Independent motor switch FET fails off • V+ regulator shorted to ground • Motor circuit open The motor has stalled, due to: • Motor drivetrain failure (high torque) • High backpressure

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
09 (MOTOR_ ERROR) cont.	008 (MOTOR_BAD_ STATE)	State #	If the motor state variable is out of range, a service alarm occurs.	The motor state variable was invalid due to: • RAM chip failure
	009 (MOTOR_BAD_ EVENT)	State #, Event # The type field is displayed as xy where x is the state # and y is the event #.	If event processing is not allowed within the current state, a service alarm occurs.	The motor received an invalid event due to: • RAM chip failure
	010 (MOTOR_BAD_ RATE)	Error # 000 = IPRF Rate 0.1 mL/hr 001 = Cont. Rate 1000 mL/hr 002 = Taper Time is zero 003 = Taper Dose is zero 004 = Taper Starting Rate 400.0 mL/hr 005 = Taper Ending Up Rate 400.0 mL/hr 006 = Taper Down Starting Rate is zero 007 = Taper Down Dose cannot be delivered with the given Starting Rate and Taper Time	When a start command is received from the infusion task, the rate is verified to be within the acceptable range of values.	The motor received an invalid rate due to: • RAM chip Failure • Bus failure
	011 (MOTOR_ STACK_ ERROR)	Error # 001 = Stack Full 002 = Stack Empty 003 = Invalid Stack Pointer detected when pushing onto the stack 004 = Invalid Stack Pointer detected when popping from the stack.	The stack is checked for space available before a state is added to the stack and for no data present before a state is removed from the stack. If a stack request cannot be processed, a service alarm occurs.	An error was detected in processing the motor stack due to: • RAM chip failure • Bus Failure
	012 (MOTOR_ STEP_ OVERLAP)	State #, Event # 15 = While homing 35 = While stepping	A timer is used to control IPRF motor steps. If the motor is homing or stepping when the timer expires, a service alarm occurs.	A motor step did not complete before the next step was requested due to: • Motor encoder strobe failure • Motor encoder failure • Motor encoder output failure • Motor clutch failure (high torque)

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
09 (MOTOR_ ERROR) cont.	013 (MOTOR_RATE _CONTROL_ ERROR)	Error # 001 = Initial Calculation 002 = Normal Operation 003 = Rate Adjustment Error log data: 27/aaa/bbb Where: aaa = counts steps (1 = on) bbb = step #	The pwm_low_counter value must always be between 0 and 10. When tested, if pwm_low_counter is ever greater than 10, the service alarm results.	Error due to: • RAM chip failure • Bus failure
	014 (MOTOR_BAD_ STEP_NUM)	Step #	At the end of each IPRF motor step, the step number is incremented and confirmed to be within the expected range for that delivery rate.	The motor was performing an invalid step due to: • RAM chip failure • Bus failure
	015 (MOTOR_ OVERSHOT)	Step # of the second (last) step that overshot Error log data: 23/000/sss 23/mmm/nnn 23/kkk/lll 23/ggg/hhh Where: sss = motor PWM mmm/nnn = NetBad2 = (mmm*100) + nnn. NetBad2 reports the net counts (fine_pos) as of the second consecutive overshot step reported in the 09/015 alarm kkk/lll = NetBad1 = (kkk * 100) + lll. NetBad1 reports the net counts (fine_pos) as of the step before the one reported in the 09/015 alarm ggg/hhh = NetGood = (ggg * 100) + hhh. NetGood reports the net counts (fine_pos) of the last step that was within tolerance (two steps before the one reported in the 09/015 alarm.)	After each IPRF step, the software checks the actual stopping position. If two consecutive steps overshoot the stopping position by two points or more, a service alarm occurs.	The motor overshot the stopping position, due to: • Software control error • Motor encoder strobe failure • Motor encoder failure • Motor servo failure

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
09 (MOTOR_ ERROR) cont.	016 (MOTOR_ ENCODER_ OVERFLOW)	(Type 1—pulse accumulator) • Back counts in prev. stroke (Type 2—output shaft scan) • Pulse accumulator value Error log data, type 1: 22/aaa/bbb 22/ccc/ddd 22/eee/fff Where: aaa = IPRF step bbb = total turns (low byte) ccc/ddd = overflow ticks as 256 * ccc + ddd eee/fff = net counts (forward minus backward) as 256 * aaa + bbb Error log data, type 2: 28/aaa/bbb 28/ccc/ddd 28/eee/fff 28/ggg/hhh 28/iii/jjj Where: aaa = number of overflows bbb = whether pulse accumulator has overflowed since previous pulse accumulator interrupt ccc/ddd = forward limit, as 256 * ccc + ddd eee/fff = total forward counts, as 256 * eee + fff ggg/hhh = forward counts on previous turn iii/jjj = total turns since starting pump	For purposes of this alarm, the maximum allowed number of forward motor counts per output shaft revolution is 432 + 80 + 8*N, where N is the number of times the motor stopped on the previous revolution. If the forward counts are found to exceed this value, a service alarm occurs.	The motor encoder overflow count was not cleared due to: • Output shaft sensor strobe failure • Output shaft sensor failure • Output shaft encoder levels out of spec., possibly due to: • sensor positioning; reflectivity of parts; component variations; supply voltage variations; open/short in OSE subsystem; flag mismounted • stripped coupling • gearbox failure • other transmission failure

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
09 (MOTOR_ ERROR) cont.	017 (MOTOR_BAD_ RESTART)	N/A	The motor ISR verifies that the current rate is not zero when it receives a restart command from the infusion task.	The motor received an invalid restart command due to: • RAM chip failure • Bus failure
	018 (MOTOR_ OVER DELIVERY)	Error 1 = Too Fast 2 = Turns Exceeded Dose Error log data, if error = 1: 19/aaa/bbb 19/ccc/ddd Where: aaa = turns observed bbb = turns max ccc = window duration, seconds ddd = dose count Error log data, if error = 2: 19/000/aaa 19/bbb/ccc 19/ddd/eee 19/fff/ggg 19/hhh/iii Where: aaa = dose count bbb/ccc/ddd/eee = output shaft turns limit, as: bbb * 256 ^ 3 + ccc * 256 ^ 2 + ddd * 256 ^ 1+ eee * 256 ^ 0 (i.e., high byte to low byte, and ^ is exponentiation) fff/ggg/hhh/iii = total observed output shaft turns, expressed high byte to low byte as above.	Every five seconds, the Infusion Safety Task tests the number of output shaft turns. If the calculated number of turns is more than 25% above the expected number of turns, a service alarm occurs. If this code appears, print out the error log from diagnostic mode.	For 09/018/001: 1) the pump is delivering at too high a rate due to: • V+ Regulator fails high • Motor servo failure • Software control fault • 180 degree miscalibration of the output shaft encoder 2) the indicated rate is above actual rate, due to: • Spurious transitions on output shaft encoder For 09/018/002, extra turns were detected, possibly due to: • Spurious transitions on output shaft encoder • Software failure to stop motor at end of dose • Motor start without permission

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
09 (MOTOR_ ERROR) cont.	019 (MOTOR_ UNDER DELIVERY)	Error 1 = Too Fast 2 = Turns Exceeded Dose Error log data, if error = 1: 19/pa1/pa2 19/000/sho 19/aaa/bbb 19/ccc/ddd Where: pa1 = pacnt_extended (high) pa2 = pacnt_extended (low) sho = short turns 000 = always zero aaa = turns observed bbb = turns max ccc = window duration, seconds ddd = dose count Error log data, if error = 2: 19/pa1/pa2 19/sho/aaa 19/bbb/ccc 19/ddd/eee 19/fff/ggg 19/hhh/iii Where: pa1 = pacnt_extended (high) pa2 = pacnt_extended (low) sho = short rev count aaa = dose count bbb/ccc/ddd/eee = output shaft turns limit, as: bbb * 256 ^ 3 + ccc * 256 ^ 2 + ddd * 256 ^ 1+ eee * 256 ^ 0 (i.e., high byte to low byte, and ^ is exponentiation) fff/ggg/hhh/iii = total observed output shaft turns, expressed high byte to low byte as above.	Every five seconds, the Infusion Safety Task tests the number of output shaft turns. If the calculated number of turns is more than 25% below the expected number of turns, a service alarm occurs. If this code appears, print out the error log from diagnostic mode.	The pump is delivering at too low a rate due to: • V+ Regulator fails low • Motor servo failure • Software control fault

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
09 (MOTOR_ ERROR) cont.	020 (MOTOR_ TAKEOFF)	Count of doses begun since the pump was powered on. Error log data: 19/pa1/pa2 19/obs/sho Where: pa1 = pacnt_extended (high) pa2 = pacnt_extended (low) obs = observed turns (low) sho = short revs The pump counts each rate change as a new dose, except for a) when resuming delivery after a purge, and b) during TPN ramping.	Every two seconds while the delivery is not in progress, the number of output shaft turns is compared with a limit value which is set whenever a dose stops (the current number of turns plus three). If the number of turns measured exceeds this limit, a service alarm occurs.	Indicated rate is above actual rate due to: • Spurious transitions on output shaft encoder Motor fails to stop when expected, due to: • Software control error
10 (BEEPER_ ERROR)	000	0 indicates digital signal was low and should have been high. 1 indicates digital signal was high and should have been low.	At power-on, when Non-Infusion Safety Task is initiated, a check is performed to determine if the beeper is emitting sound. If the signal is high when the beeper should be off or low; or when the beeper should be on, a service alarm is activated.	An incorrect digital signal could indicate that the beeper is not functioning properly or that the circuitry designed to check the beeper is malfunctioning.
11 (POWER_ SENSING_ ERROR)	000 (OVERVOLT _5V)	ADC 5 V input reading	The 5 V line is tested at power on and once each second. If the voltage is greater than expected, a service alarm occurs.	More than 5.5 volts is measured on the 5 V line due to: • 5 V regulator failure • Power sensing circuitry failure
	001 (UNDERVOLT _5V)	ADC 5 V input reading	The 5 V line is tested at power on and once each second. If the voltage is less than expected, a service alarm occurs.	Less than 4.5 volts is measured on the 5 V line due to: • 5 V regulator failure • Power sensing circuitry failure

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
11 (POWER_ SENSING_ ERROR) cont.	002 (OVERVOLT _ALK)	ADC Battery compartment input reading	The AA battery input line is tested at power on and once each second. If the voltage is greater than expected, a service alarm occurs.	More than 3.2 volts is measured on the battery voltage input due to: • Improper type of batteries installed
	003 (OVERVOLT _EXT)	ADC External power input reading	The external power input line is tested at power on and once each second. If the voltage is greater than expected, a service alarm occurs.	More than 3.6 volts is measured on the external input due to: • Power sensing circuitry failure
	004 (NO_LITHIUM)	ADC Lithium input reading	The lithium battery input line is tested at power on and once each second. If the voltage is less than expected, a service alarm occurs.	Less than 2.0 volts is measured on the lithium battery input due to: • Lithium battery discharged • Lithium battery output shorted
12 (STUCK_ KEY)	N/A	Key value	At power on the keypad is scanned. If a key is active, an error message is displayed. If the key continues to be active for more than one minute, a service alarm occurs. The keypad ISR scans for key presses and tests each read against the previous one. If a key is active continuously for more than one minute, a service alarm occurs.	A stuck key press was detected due to: • Keypad failure

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
13 (TIME_ BASE_ ERROR)	000	Number of RTIs counted	The number of elapsed RTIs is tested once each second. If the number is within the expected range, the count is zeroed. If the number is not within the expected range, a service alarm occurs.	Timing error due to: • Oscillator failure • RTI failure
	001	Number of RTIs counted	The number of elapsed RTIs is incremented and tested once each RTI. If the number exceeds the upper limit value since the last one-second interrupt, a service alarm occurs.	Timing error due to: • Oscillator failure • Clock chip failure • IRQ interrupt failure
14 (WATCHDOG _ERROR)	001	Reading of PACNT	At power on the watchdog PIC is tested by overstrobing it while trying to run the motor. If the motor moves more than 20 counts, a service alarm occurs.	Watchdog PIC circuit is not functioning, due to: • PIC being in its disabled mode • PIC failure • Fault in connection between PIC and motor power regulator SHDN pin • Motor is being moved by pushing on plunger during PIC test
	003	Task Number 1 = Infusion Safety 2 = Non-Infusion Safety 3 = Pressure 4 = Motor 5 = Display Manager 6 = (Not used) 7 = Keypad 8 = Infusion	Various periodic tasks update progress counters to indicate that they are still running. Other periodic tasks check those counters and count the number of checks that have gone by without a change in the counter. When the number of checks without change exceeds 20, a service alarm occurs.	A periodic task has stopped updating its counter, due to: • RAM corruption or error • Task deadlock • Programming error

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
15 (POWER_ DOWN_ ERROR)	N/A	System State 0 = Power On 1 = Normal Operation 3 = Service Alarm 4 = Power Off 5 = Power Down Started	At power on the system state is tested. If power down processing completed, power on processing continues. If the system began power down processing, but did not complete it, a service alarm message is logged to the history and processing is allowed to continue. If the power down processing did not start, a service alarm occurs.	The pump did not perform normal power down processing due to: • Hardware reset
16 (SOFTWARE_ ERROR)	001 (INVALID_ STATE)	0	The Infusion Safety Task tests the air-in-line alarm status when it receives a start or restart command. If the alarm is already active, a service alarm occurs.	The air in line was active when it should not be due to: • RAM chip failure • Bus failure
	002 (KEY_EVENT_ TIMEOUT)	Task ID	The call back functions failed to send an acknowledgement message to the IED task within 6 seconds after receiving a key-event.	Tasks are in deadlock condition.
	003 (INVALID_ ALARM_ SEMAPHORE)	Semaphore value	The alarm task verifies semaphore values when received. If processing is not defined for a semaphore value, a service alarm occurs.	The alarm task received an invalid alarm semaphore value due to: • RAM chip failure • Bus failure

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
16 (SOFTWARE_ ERROR) cont.	004 (INVALID_ ALARM_ MESSAGE)	Action value	The alarm task verifies actions requested when a mailbox message is received. If processing is not defined for an action value, a service alarm occurs.	The alarm task received an invalid alarm action request due to: • RAM chip failure • Bus failure
	005 (INVALID_ ALARM_ TYPE)	Alarm type value	The alarm task verifies alarm types requested when a mailbox message is received, when alarms are logged to the history, and when an alarm status is requested. If the alarm type received is invalid, a service alarm occurs.	The alarm task received an invalid alarm type due to: • RAM chip failure • Bus failure
	006 (INVALID_ ALARM_ CALLBACK)	Callback ID	The alarm task verifies callback IDs when a key press is passed to the alarm callback processing function. If the callback ID is invalid, a service alarm occurs.	An invalid alarm callback type was requested due to: • RAM chip failure • Bus failure
	007 (INVALID_ SOUND_TYPE)	Sound type value	The audible alarm processing functions that start and stop sounds verify the values passed to them. If an invalid sound type is requested, a service alarm occurs.	An invalid sound type was requested due to: • RAM chip failure • Bus failure
	008 (IQUEUE_FULL)	Queue # 0 = Air In 1 = Air Out 2 = Pressure In 3 = Pressure Out 4 = Motor In 5 = Motor Out 6 = Infusion Safety In 7 = Keypad Out	When the queue processing function receives a request to add data to a queue, it verifies that there is space available in the queue. If the queue is full, a service alarm occurs.	A request was received to add data to a queue that was already full due to: • CPU overload • software control fault • receiving task unresponsive

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
16 (SOFTWARE_ ERROR) cont.	009 (ISA_INVALID_ MSG)	0	When the Infusion Safety Task receives an unrecognizable message code, a service alarm occurs.	The Infusion Safety Task received an invalid message type due to: • RAM chip failure • Bus failure
	010 (ISA_NULL_ MSG)	0	When RTXC passes a NULL message to the Infusion Safety Task, a service alarm occurs.	The Infusion Safety Task received a null message type due to: • RAM chip failure • Bus failure
	011 (ISA_ INVALID_ PRESSURE)	Message Data value	The Infusion Safety Task checks the pressure message type code when received. If it is not a recognized value, a service alarm occurs.	The Infusion Safety Task received an invalid pressure message due to: • RAM chip failure • Bus failure
	012 (ISA_EMPTY_ IQUEUE)	Queue # 0 = ISA_AIR-ADC 1 = ISA_PRESS_MSG2 2 = ISA_PRESS_ADC 3 = ISA_NO_MSG	The Infusion Safety Task reads from queues when processing the ISR semaphore. If the air and pressure queues are empty or if a check cassette message was received without a type value, a service alarm occurs.	The Infusion Safety Task did not receive expected queue information due to: • Software Error • RAM chip failure • Bus failure
	013 (ISA_BAD_ SEMAPHORE)	0	The Infusion Safety task verifies semaphore values when received. If processing is not defined for a semaphore value, a service alarm occurs.	The Infusion Safety Task received an invalid semaphore value due to: • RAM chip failure • Bus failure
	014 (ISA_INVALID_ AIR)	Message Data value	The Infusion Safety Task verifies air message data when received. If processing is not defined for an air message value, a service alarm occurs.	The Infusion Safety Task received an invalid air message due to: • RAM chip failure • Bus failure

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
16 (SOFTWARE_ ERROR) cont.	015 (ISA_BAD_CK_ CASS_CODE)	Bad Check Cassette Code	The Infusion Safety Task verifies check cassette message data when received. If processing is not defined for a check cassette message, a service alarm occurs.	The Infusion Safety Task received an invalid check cassette message due to: • RAM chip failure • Bus failure
	016 (ISA_BAD_ RESUME)	0	The Infusion Safety Task verifies that a prior "start" message has been received when it receives a "resume" message. If this is not the case, a service alarm occurs.	Software error • RAM error
	017 (ISA_RATE_ MISMATCH)	0 = ITD_NO_DELIVERY 1 = ITD_TAPER_UP 2 = ITD_TAPER_DOWN 3 = ITD_CONTINUOUS 4 = ITD_BOLUS 5 = ITD_LOAD_DOSE 6 = ITD_PURGE 7 = ITD_PIGGYBACK 8 = ITD_KVO 9 = ITD_AUTOKVO 10 = ITD_PHASE 11 = ITD_BASE_RATE 12 = ITD_INTERMITTENT Error log data: 20/aaa/bbb 20/ccc/ddd 20/aaa/bbb 20/ccc/ddd Where aaa/bbb = isafety rate, as 256 * aaa + bbb ccc/ddd = infusion task rate, as 256 * ccc + ddd	Every two seconds, a structure containing the pump's rate and other data is cross-checked against the rate contained in the Infusion Safety Task. If these rates do not match for eight consecutive samples, a service alarm occurs. If you get this code, print out the error log from diagnostic mode.	• Software error • RAM error

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
16 (SOFTWARE_ ERROR) cont.	018 (ISA_MODE_ MISMATCH)	0xy x = infusion task's "infusing" flag (1 = yes, 0 = no) y = value of global_main_mode 1 = PROGRAMMING _MODE 2 = REVIEW_MODE 3 = STOP_MODE 4 = RUN_MODE 5 = CHANGE_MODE 6 = OPTIONS_MODE 7 = MAX_MODE_TYPES	Every two seconds, the variables global_main_mode and pump-infusing are compared for consistency. If three samples in succession are not consistent, a service alarm occurs.	• Software error • RAM error
	020 (REMOTEQ_ OUT_ FULL)	1 = Remote Queue for the output message is full	When a message needs to be stored at the end of the outgoing message queue and it is full, a service alarm occurs.	• Software error • RAM error • The flow rate of the outgoing messages is too slow.
	021 (REMOTEQ_ OUT_ EMPTY)	1 = Remote Queue for the outgoing message is empty	When the SCI_OUTPUT task is attempting to send an outgoing message to the serial port, or attempting to free a message from an empty queue, a service alarm occurs.	• Software error • RAM error
	022 (REMOTEQ_ OUT_BAD_ STATE)	1 = Remote Queue for the outgoing message is in bad state	When a message needs to be stored at the end of the outgoing message queue and it is in a bad state, a service alarm occurs.	• Software error • RAM error
	023 (ISA_BAD_ RATE)	1 = Taper Overrate Error 2 = Standard Delivery Overrate Error	If a tapered rate is greater than 450 mL/hr or a non-tapered rate is greater than 1000 mL/hr, a service alarm occurs	• Software Error • RAM Error

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
16 (SOFTWARE_ ERROR) cont.	024 (INVALID_TIME _IN_ SECONDS)	0	If the pump has a program in it and has the time set such that the pump rolls over from 2002 to 2003, the service alarm occurs and the current program is erased. If the pump is on at midnight, January 1, 2003, the alarm will occur immediately. If the pump is off at midnight, January 1, 2003, the next time it is on it will alarm.	• Pump clock rolls over from 2002 to 2003
18 (HISTORY_ PTR_ERROR)	000 (WRITE_HLOG_ ERROR)	xxx xxx is debug information	Each time a record is written to the history, the history pointers are tested. If the pointers are not within the accepted limits, a service alarm occurs.	History pointers became corrupted due to: • RAM chip failure • Bus failure
	001 (TRAVERSING_ TO_BOTTOM_ ERROR)	xxx xxx is debug information	Each time the get_prev_hrecord ( ) is called, the top and the bottom pointers are checked to insure the pointers are pointing in the ranges as expected.	History pointers became corrupted due to: • RAM chip failure • Bus failure
	002 (TRAVERSING_ TO_ TOP_ERROR)	xxx xxx is debug information	Each time the get_next_hrecord ( ) is called, the top and the bottom pointers are checked to insure the pointers are pointing in the ranges as expected.	History pointers became corrupted due to: • RAM chip failure • Bus failure
21 (COMM_ ERROR)	000 (IN_BUF_ERR)	000 (MAX_OVERRUNS_ EXCEEDED)	When SCI_interrupt attempts to add a byte to a full data buffer, a service alarm occurs.	• Data communication error

Table 6-6. Service Alarm Code – Detail

Primary Error (NN)	Supplemental Error (MMM)	Type (TTT)	Error Detection Method	Error Description/ Possible Causes
21 (COMM_ ERROR) cont.	000 (IN_BUF_ERR)	001 (REMOTE_INPUT_ QUEUE_ EMPTY)	When SCI Input task attempts to extract data from an empty incoming-message queue, a service alarm occurs.	• Data communication error
	002 (IN_MSG_ERR)	004 (BAD_KEY_MSG)	When SCI Input task receives an unknown key-event, a service alarm occurs.	• Data communication error
	002 (IN_MSG_ERR)	005 (BAD_MSG_TYPE)	When SCI Input task receives an unknown message type, a service alarm occurs.	• Data communication error
	002 (IN_MSG_ERR)	006 (BAD_SESS_RQST)	When SCI Input task receives a bad session request message, a service alarm occurs.	• Data communication error

6.4
OPERATIONAL ALARMS

Table 6-7. Operational Alarms

Operational Alarm	Format	Description

Air-in-Line	(nnn)	❑ nnn represents the signal being read by the air sensor.
		❑ The expected reading for a well-seated cassette ranges from 80 to 180. Readings in the 50–80 range can signify one of the following:
		  ❑ A buildup of fine bubbles near the outlet of the cassette (which is where the air sensor is located),
		  ❑ The distal tube has been partially pulled out of its position between the "pincers" of the air sensor,
		  ❑ There is air in the tube and the outside of the tube is wet
		❑ Very low readings (1–5) are usually caused by air-in-line, but can also be caused by pulling very hard on the distal tube.
		❑ A reading of zero indicates either air in the tube or a broken sensor. If a primed set is loaded in the pump and air alarms occur with a reading of zero, the sensor needs to be replaced.

Check Cassette	(P nnn)	❑ nnn above 150 signifies high pressure upstream, and one of the following is usually the problem:
		  ❑ Fluid was injected (with a syringe) into an upstream Y-site and there is a back-check valve in place. Fluid must be injected slowly (i.e., at the delivery rate or less) into such a port.
		  ❑ User pressed syringe during delivery. Use Abbott recommended syringe-sizes, and use a syringe-adapter for the very small-bore syringes.
		  ❑ The pump was pumping near maximum rate with the container more than two feet above the pump. This can produce large increases in the inlet pressure. Lower the container or reduce the rate.
		  ❑ The outside of the cassette has a sticky build-up on its pressure sensing hole. Look at the part of the cassette that faces the pump and make sure it is free of debris and sticky or dried liquids. Also confirm that the "pocket" (in the side of the pump) in which the cassette fits is reasonably clean.
		❑ nnn below 90 indicates the cassette has been fully or partly unlatched. Confirm that the cassette is fully "snapped in" at both ends. Pressing on the middle of the cassette usually solves the problem.

Check Cassette	(D nnn)	❑ The distal pressure sensor has detected a condition indicating that the cassette is not properly latched at the outlet end. Confirm that the cassette is fully "snapped in" at both ends. Pressing on the middle of the cassette usually solves the problem.

Table 6-7. Operational Alarms

Operational Alarm	Format	Description
Check Cassette	(A nnn)	❑ nnn represents the signal being read by the air sensor. When this alarm occurs, the number should be above 180. The problem could be: ❑ The tubing by the sensor has been flattened by using the set for a long time or in high temperatures. Tugging gently on the distal line will often relieve the problem. ❑ The tubing by the sensor is wet on the outside, making accurate readings difficult. Confirm the tube is reasonably dry.
Proximal Occlusion	(nnn)	❑ The inlet pressure is not high enough to allow delivery. The inlet tubing may be clamped, the valve on a ball-check set or burette set may be closed, or a syringe may be stuck. ❑ nnn does not provide any information to help determine the source of the problem; it is used by engineering to track cassette performance.
Distal Occlusion	(nnn)	❑ The outlet pressure is too high. One of the following has probably occurred: ❑ The outlet tube is clamped or a manifold valve is closed. ❑ The patient line is restricted. Check for kinks and clots. ❑ The distal occlusion setting is too low for the pump or fluid in use. Filter, narrow-bore tubing, thick fluid, or a fine-gauge needle can elevate distal pressure at the pump. ❑ Pumping into an elevated patient can also cause this alarm. ❑ Use a higher pressure setting, reduce the restrictions, or lower the delivery rate.
Switch to Batteries	(nnn)	❑ nnn is the ADC value measured by the pump.
Low Batteries	(nnn mmm)	❑ nnn is the internal ADC value measured by the pump. ❑ mmm is the external ADC value measured by the pump.
Power Loss	(H) or (S)	❑ (H) if the Power Loss was initiated by the hardware ❑ (S) if the Power Loss was initiated by the software

Section 7

REPLACEABLE PARTS AND REPAIRS

The warranty shall be void in the event any person, including the Purchaser, performs or attempts to perform any major repair or other service on the product without having been trained by an authorized representative of Abbott and using Abbott documentation and approved spare parts. For purposes of the preceding sentence, "major repair or other service" means any repair or service other than the replacement of accessory items such as batteries.

7.1 SAFETY PRECAUTIONS

WARNING:	**UNLESS OTHERWISE INDICATED, DISCONNECT THE INFUSION SYSTEM FROM INTERNAL AND EXTERNAL POWER SOURCES BEFORE PERFORMING ANY REPLACEMENT PROCEDURE.**

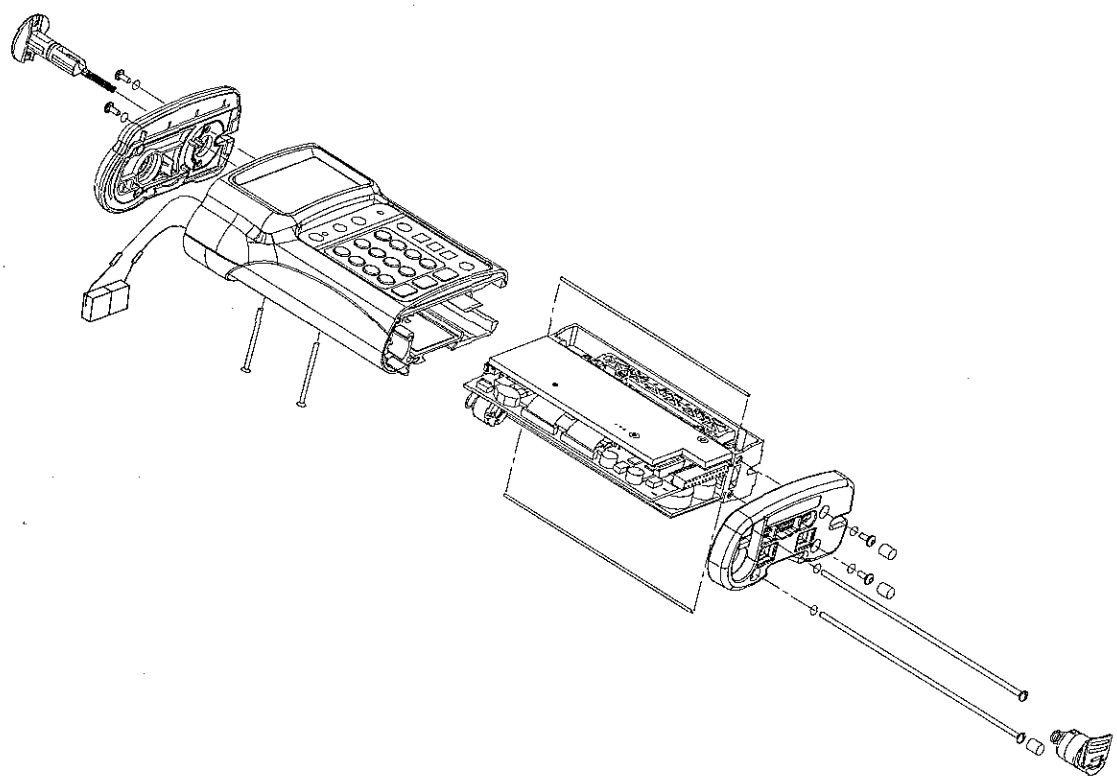
WARNING:	**POSSIBLE EXPLOSION HAZARD IF PRODUCT IS SERVICED OR REPAIRED IN THE PRESENCE OF FLAMMABLE ANESTHETICS.**

CAUTION: Use proper ESD grounding techniques when handling components. Wear an anti-static wrist strap and use an ESD-protected workstation. Store the PCB in an anti-static bag before placing it on any surface.

7.2 PUMP DISASSEMBLY

The Abbott GemStar pump has no user-serviceable components, with the exception of disposable batteries.

Pump disassembly and assembly is performed only by Abbott certified technicians. *Figure 7-1, Abbott GemStar Pump Exploded View* is provided for reference only.



02G02038

Figure 7-1. Abbott GemStar Pump Exploded View

Section 8

SPECIFICATIONS

PHYSICAL

The Abbott GemStar pump is composed of latex-free components only.

Dimensions: Height: 5.5 in. (14.0 cm)
Width: 3.8 in. (9.7 cm)
Depth: 2.0 in. (5.1 cm)

Weight: Approximately 17 oz. (482 grams) excluding batteries

TRANSPORT AND STORAGE ENVIRONMENT

Store in cool and dry environment.

Ambient Temperatures: -4° to +140° F (-20° to +60° C)

Relative Humidity: 10% to 90%

Atmospheric Pressure: 0 - 10,000 ft. (0 - 3,000 m) equivalent pressure

OPERATING ENVIRONMENT

Ambient Temperatures: +41° to +104° F (+5° to +40° C)

POWER SOURCES

AC Mains: Wall-mount AC (mains) adaptor;
6 ft. (1.8 m) cord; molded plug
Input: 110 V_{AC}
Output: 3.0 V_{DC}

Tabletop AC (mains) adaptor; molded plug
Input: 100 - 240 V_{AC}
Output: 3.0 V_{DC}

Battery: Two disposable AA or lithium batteries

Battery Pack: Rechargeable using Abbott GemStar AC (Mains) Adaptor

POWER CAPACITY

Using two fresh, disposable AA batteries or a charged battery pack, at room temperature, the pump is capable of delivering approximately:

96 hours at rates below 5 mL/hr
48 hours at rates at or above 5 mL/hr but below 25 mL/hr
24 hours at rates at or above 25 mL/hr but below 125 mL/hr
3000 mL at a rate of 125 mL/hr or higher

PUMP MECHANISM

Volumetric; Piston Driven

MEMORY PROTECTION

Current program and 400-event (history) log protected by internal lithium battery-backed memory for at least one year after power is removed

OPERATING CONTROLS

One 23-key keypad; bolus, data port, and AC (mains) jacks; bolus button

EXTERNAL POWER LED

Green LED marked with plug icon illuminates continuously when pump is connected to AC (mains)

Green LED flashes when pump is connected to external batteries

ALARM LED

Red LED marked with alarm icon illuminates during alarm conditions

AUDIBLE ALARM

The audible alarm is user-adjustable from the maximum volume down to silent

The alarm automatically reverts to the maximum volume if the user does not respond within one minute

DISPLAY

Backlit, four-line-by-sixteen-character alphanumeric graphics display

Backlight on AC: Continuous

Backlight on Batteries: Continuous during programming, program review, and history display; otherwise activated by key press or alarm; not activated by bolus request

REAL TIME CLOCK

Accuracy of ±1 minute per month or better

PRINT FUNCTION

Port and Interface: RS-232 serial interface port, minimum baud rate of 2400, isolated circuit

Printers: Seiko DPU 414 or compatible serial printer

SYSTEM ACCURACY

± 10% for rates of 0.1 to less than 5 mL/hr
± 5% for rates of 5 to 1000 mL/hr

AIR SENSITIVITY

ON: Pump alarms at approximately 0.5 mL of air

Alarms for any bubble greater than 500 microliters with a tolerance of 200 microliters

2 mL: Pump alarms at approximately 2 mL of air

Alarms when pump detects 2.0 +1.0/-0.2 mL of air in 6 mL of total volume delivered

OFF: Alarm is not activated

Recommend using air-eliminating filter when Air Sensitivity is off

OCCLUSION SENSITIVITY

Distal Occlusion

Low: Alarms when pump detects distal pressure greater than 7 psi (48 kPa) ± 5 psi (± 34 kPa)

Medium: Alarms when pump detects distal pressure greater than 12 psi (83 kPa) ± 8 psi (± 55 kPa)

High: Alarms when pump detects distal pressure greater than 26 psi (179 kPa) + 14 psi (+ 96 kPa)

Proximal Occlusion: Alarms when pump detects proximal pressure less than or equal to -4 psi (-28 kPa)

PIGGYBACK RATE

0.1 - 300 mL per hour

PUMP SELF-TESTS AND SAFETY FEATURES

Self-test performed when the power switch is activated

Diagnostic routine, including motor speed and air-detection monitoring, is repeated continuously while the pump is powered on

Error and alarm conditions are indicated by both audible and visual alarms; delivery in progress is stopped, if appropriate *(refer to Section 6, Troubleshooting).*

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Section 9
DRAWINGS

Figure 9-1 through *Figure 9-4* show the PWA schematic diagrams. *Table 9-1, Drawings*, lists drawings by figure number, title, and part number.

Drawings and schematics in *Section 9* are provided as information only; drawings and schematics may not exactly reflect current product configuration.

Table 9-1. Drawings

Figure No.	Title	Part Number
9-1	Abbott GemStar Boards	102665
9-2	GemStar Top Board (2 Sheets)	
9-3	GemStar Middle Board (3 Sheets)	
9-4	GemStar Bottom Board (3 Sheets)	

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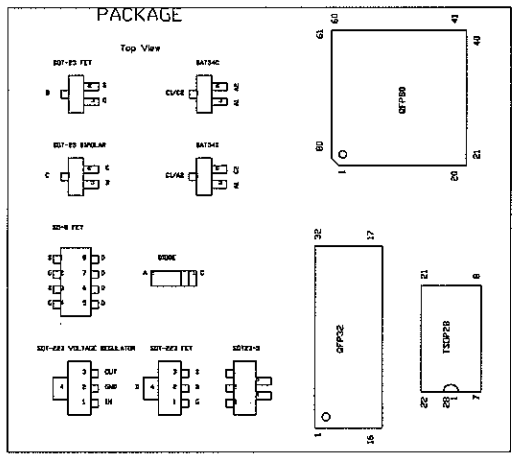

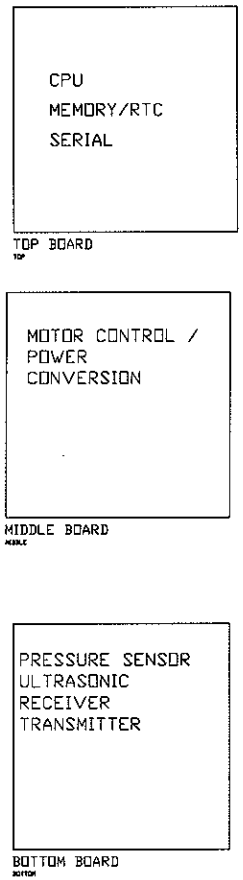

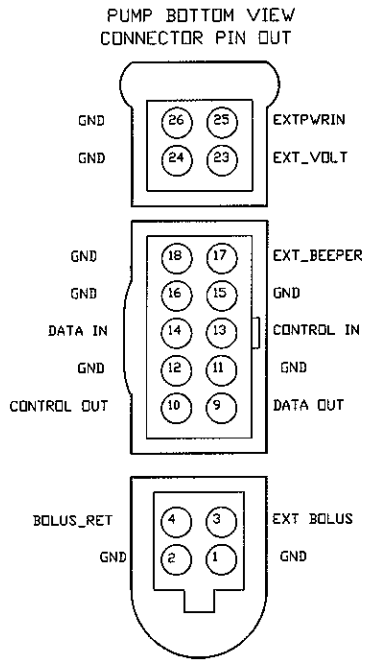

ABBOTT LABORATORIES HOSPITAL PRODUCTS DIVISION - RM	
Figure 9-1. Abbott GemStar	
DRAWING NO. 102685	Rev. E
	Sheet 1 of 1

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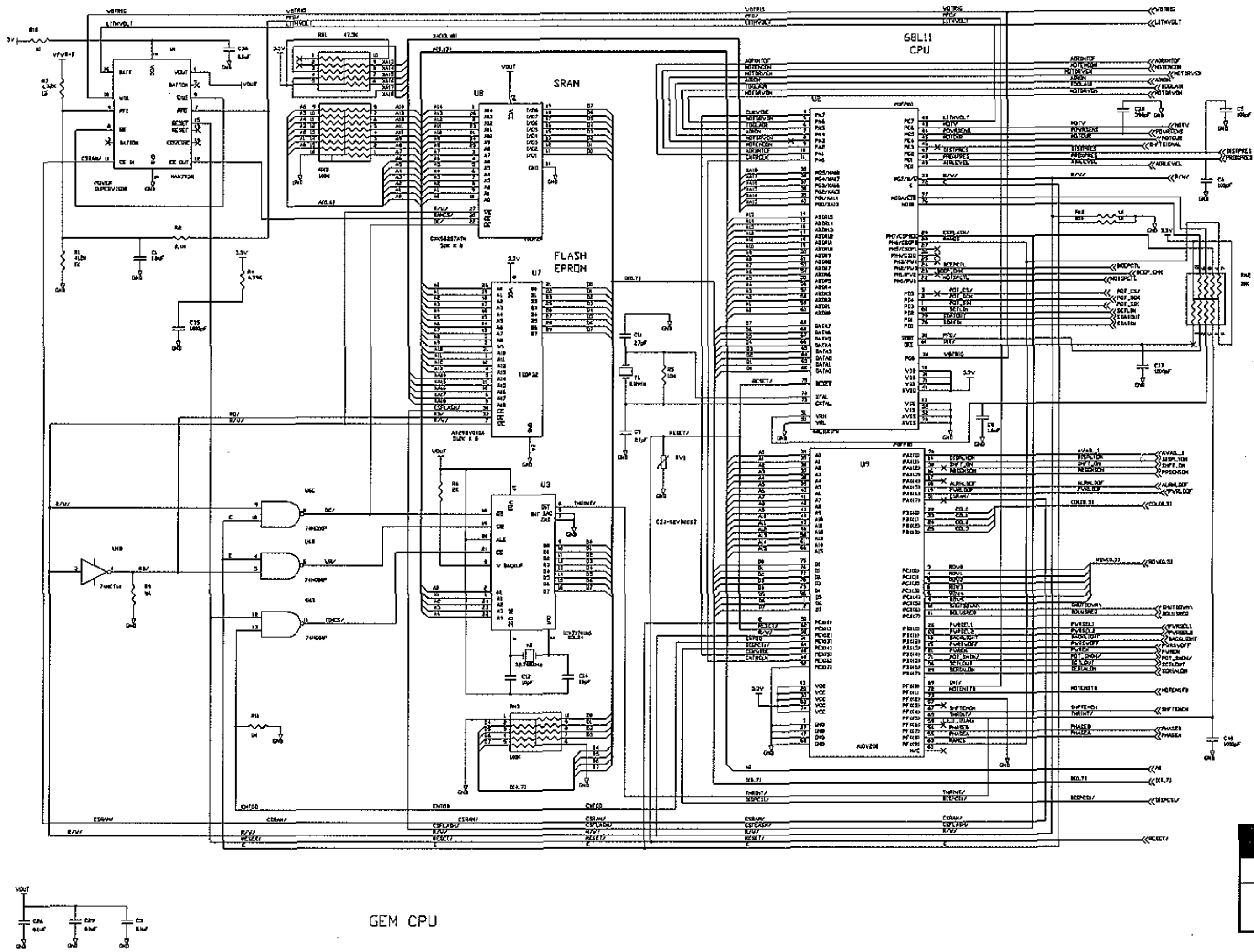

ABBOTT LABORATORIES HOSPITAL PRODUCTS DIVISION - MH

Figure 9-2. GemStar Top Board

DRAWING NO. 102665	Rev. E
	Sheet 1 of 2

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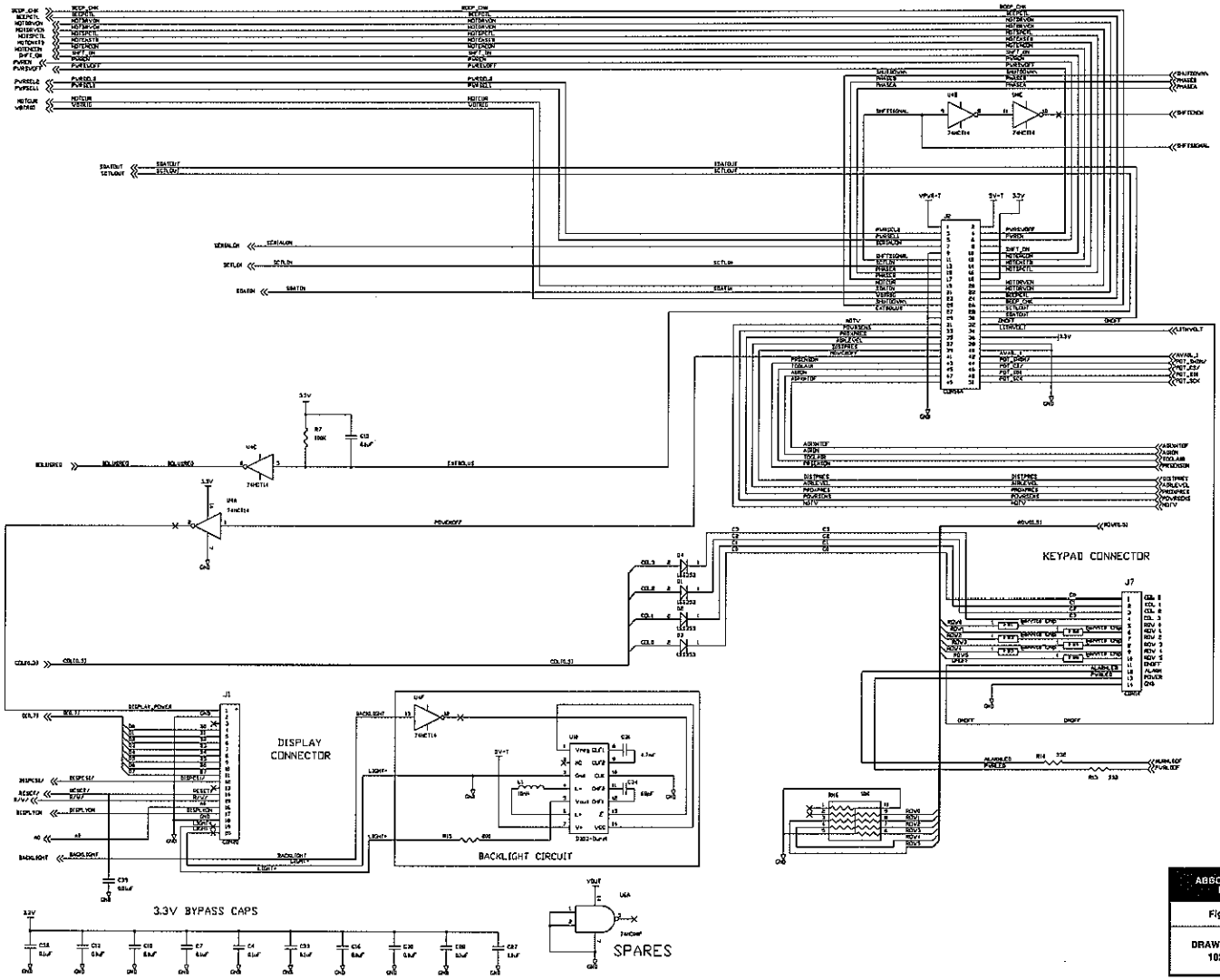

ABBOTT LABORATORIES HOSPITAL PRODUCTS DIVISION - MH	
Figure 9-2. GemStar Top Board	
DRAWING NO. 102885	Rev. E
	Sheet 2 of 2

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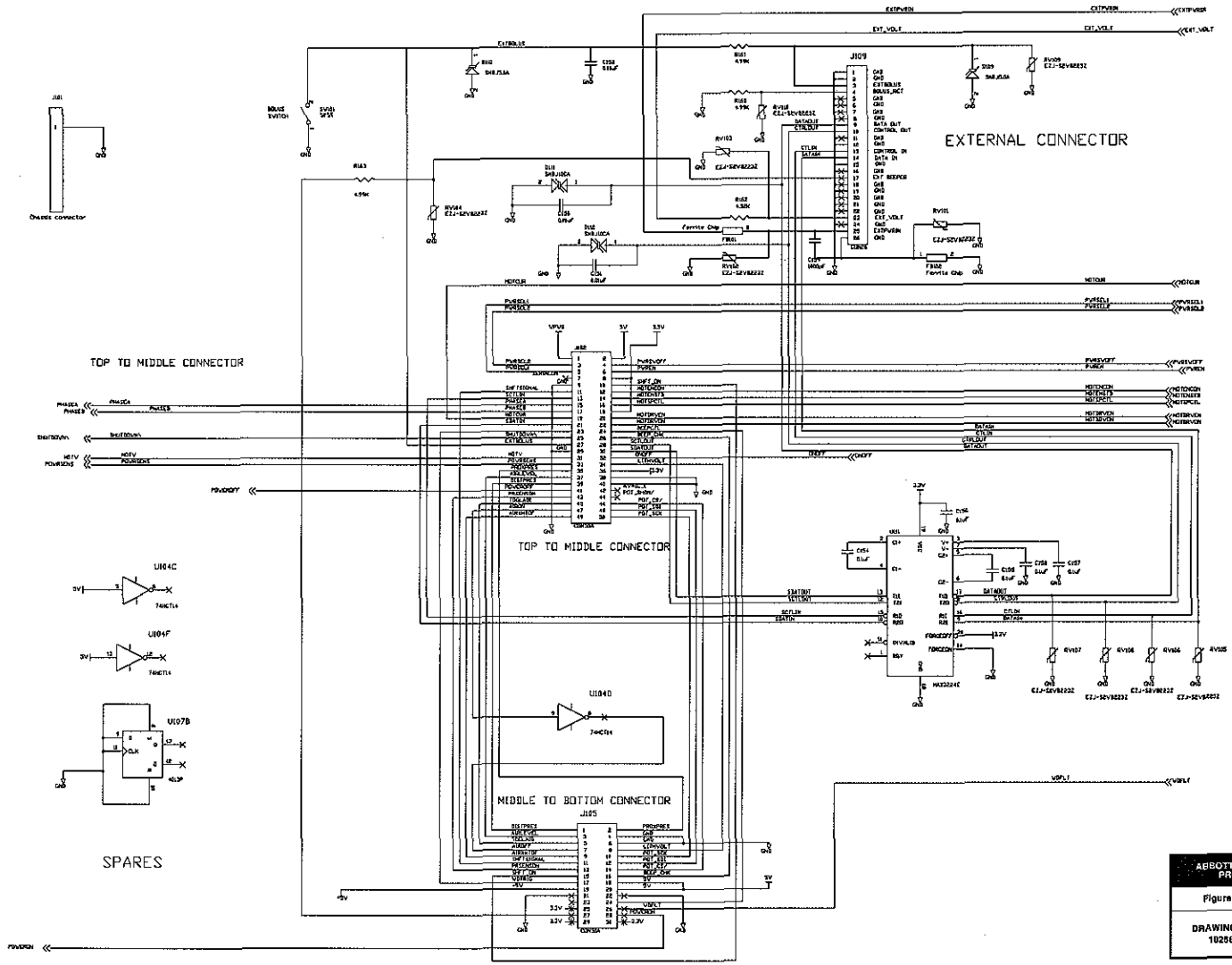

ABBOTT LABORATORIES HOSPITAL PRODUCTS DIVISION - MH	
Figure 9-3. GemStar Middle Board	
DRAWING NO. 102565	Rev. E
	Sheet 1 of 3

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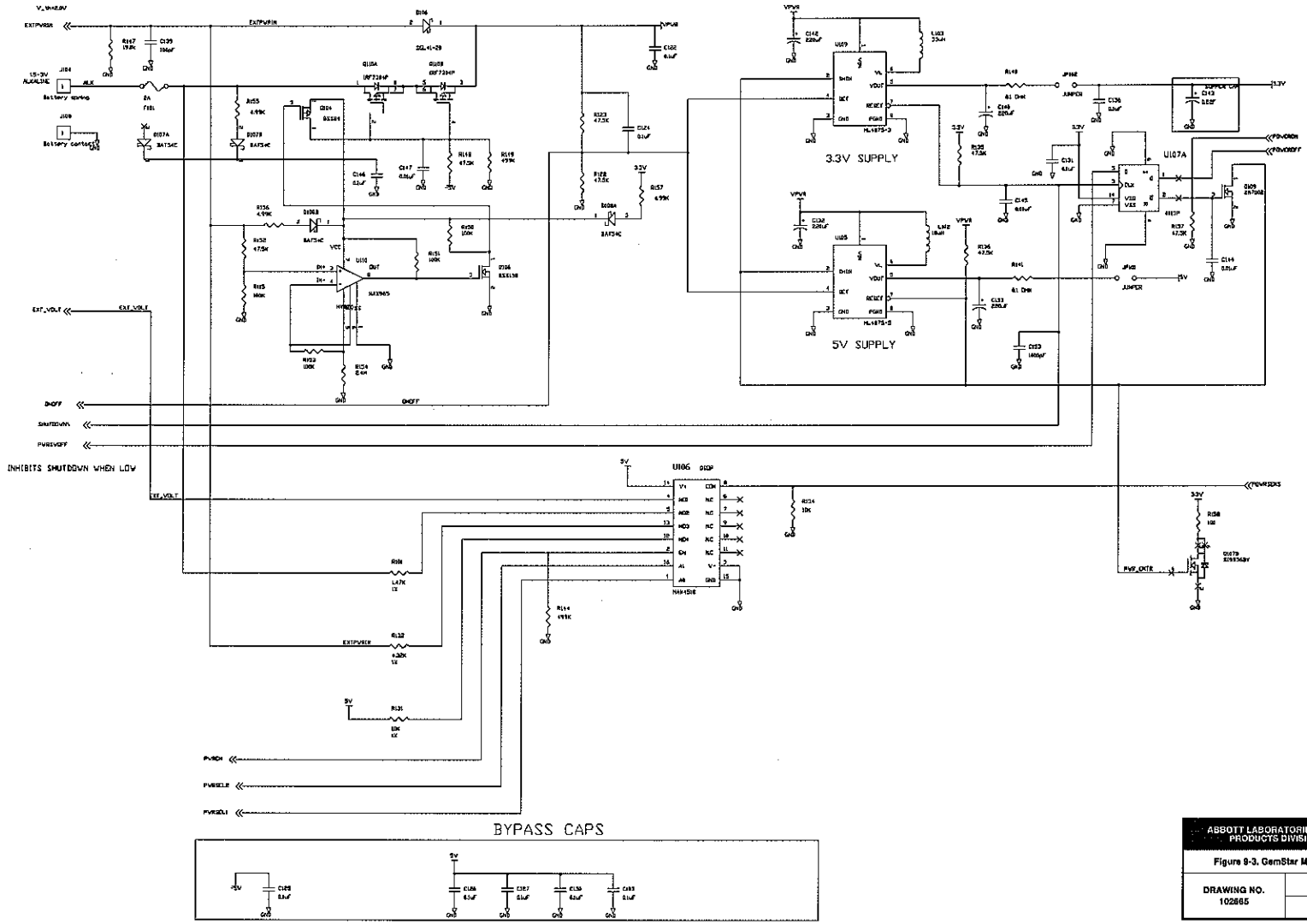

ABBOTT LABORATORIES HOSPITAL PRODUCTS DIVISION - MH	
Figure 9-3. GemStar Middle Board	
DRAWING NO. 102665	Rev. E
	Sheet 2 of 3

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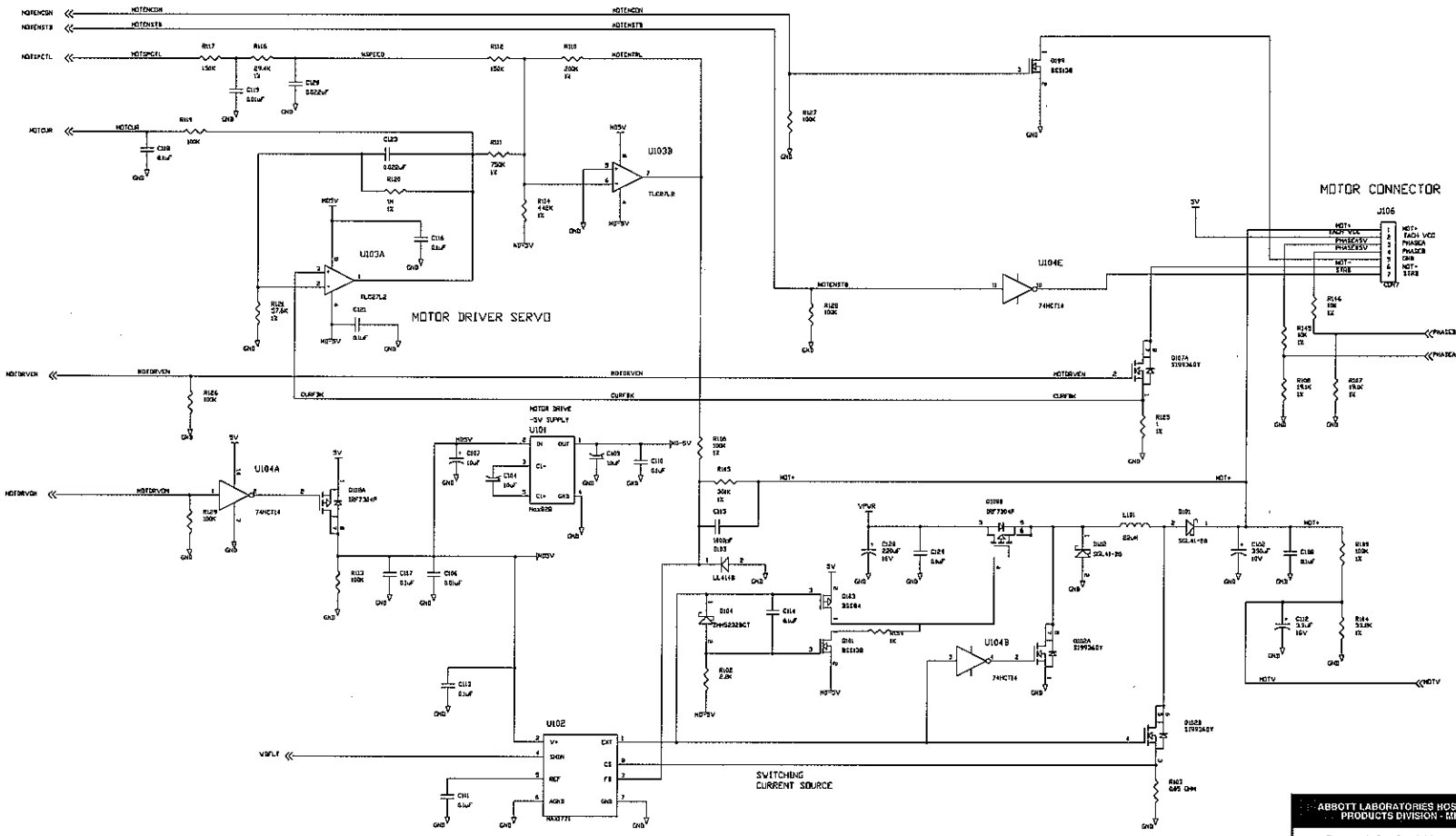

ABBOTT LABORATORIES HOSPITAL PRODUCTS DIVISION - MH	
Figure 9-3. GemStar Middle Board	
DRAWING NO. 102665	Rev. E
	Sheet 3 of 3

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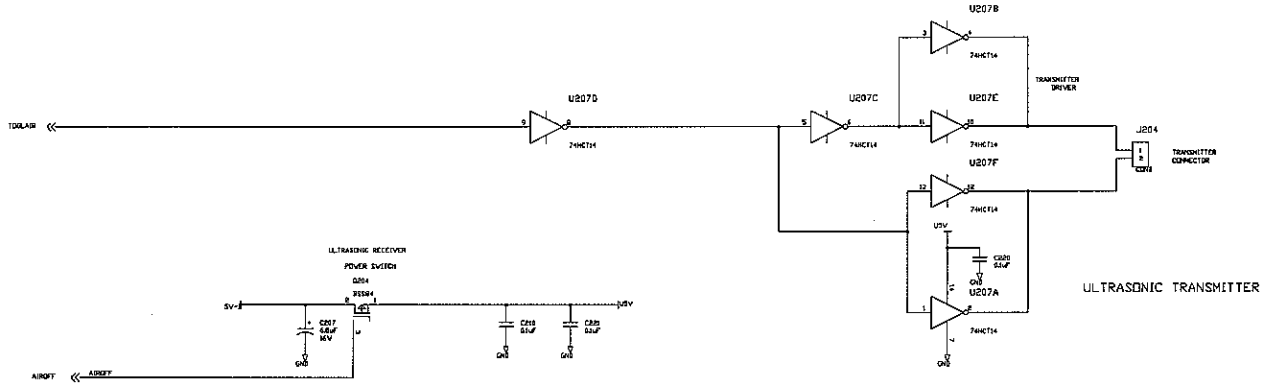

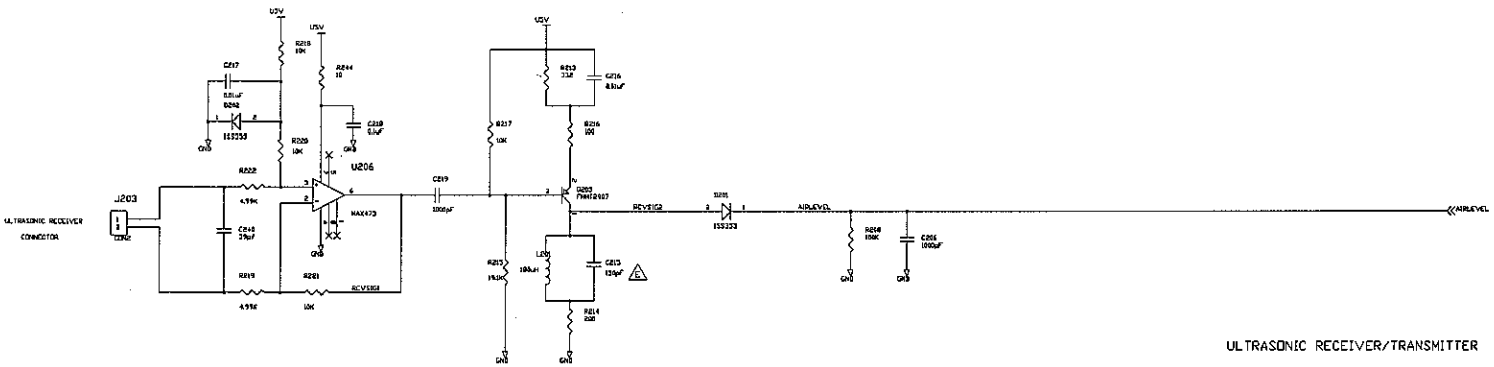

ABBOTT LABORATORIES HOSPITAL PRODUCTS DIVISION - MH	
Figure 9-4. GemStar Bottom Board	
DRAWING NO. 102665	Rev. E
	Sheet 1 of 3

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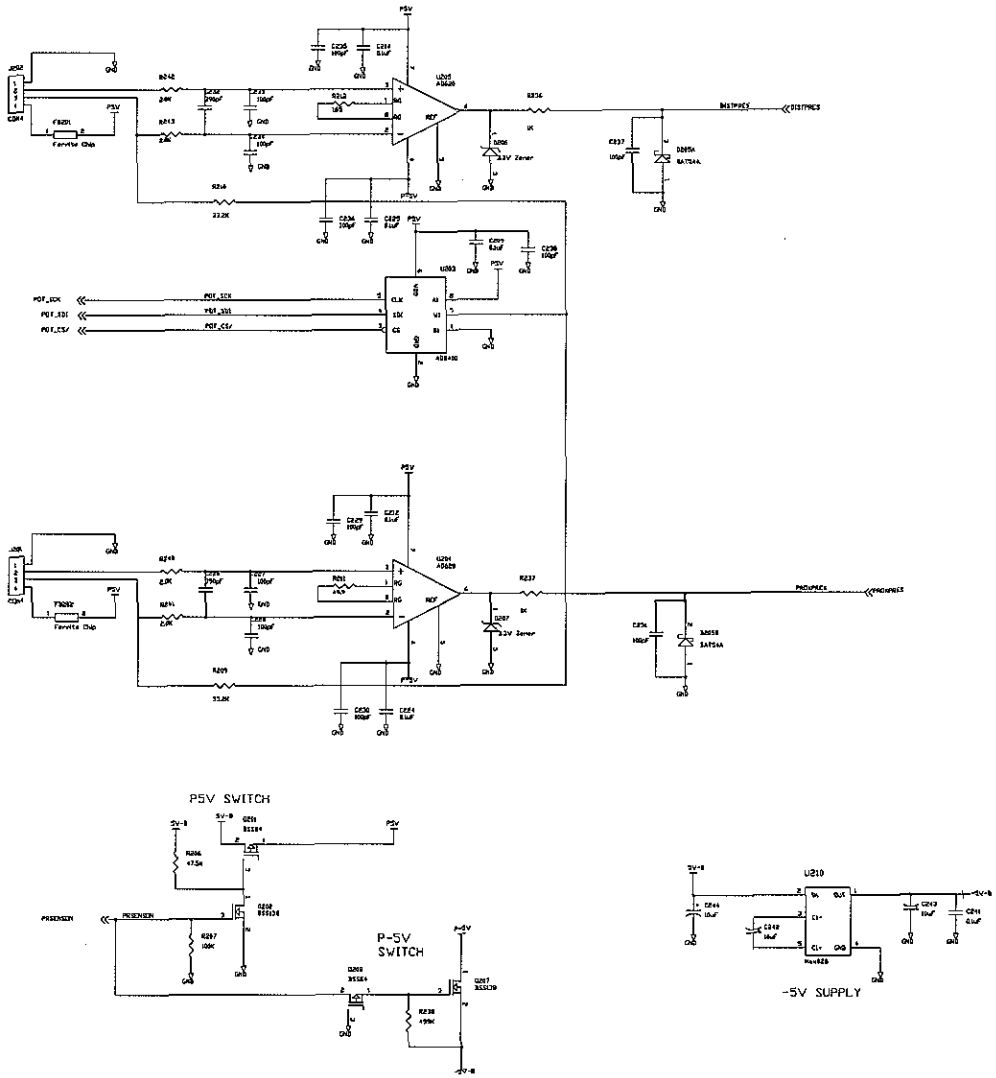

PRESSURE SENSOR INTERFACE

ABBOTT LABORATORIES HOSPITAL PRODUCTS DIVISION - MH	
Figure 9-4. GemStar Bottom Board	
DRAWING NO. 102685	Rev. E
	Sheet 2 of 3

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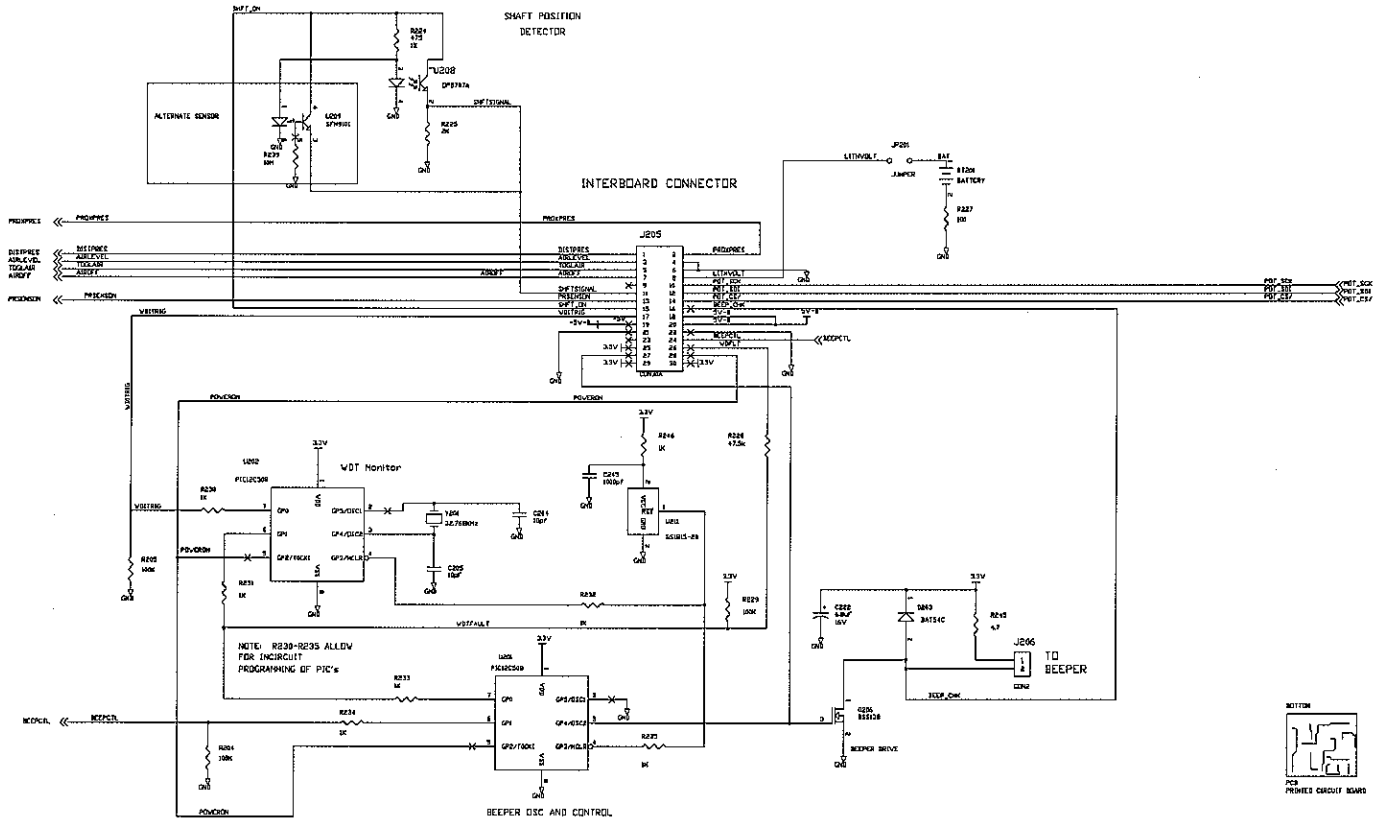
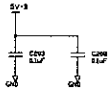
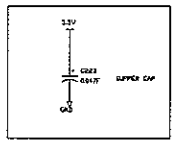


BYPASS CAPS





ABBOTT LABORATORIES HOSPITAL PRODUCTS DIVISION - RH	
Figure 9-4. GemStar Bottom Board	
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Section 10
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1-800-241-4002

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CAUTION: Federal (USA) law restricts this device to sale by or on the order of a physician or other licensed practitioner.

DANGER:	**POSSIBLE EXPLOSION HAZARD EXISTS IF USED IN THE PRESENCE OF FLAMMABLE ANESTHETICS.**

CE 0050

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C22.2 No 601.1

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Type BF

Equipment providing a degree of protection higher than that for Type B equipment against electrical shock particularly regarding allowable leakage currents and having an F-Type applied part.

IPX1 Protected against dripping water.

Attention: Consult accompanying documents.

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